

Regional Observing Systems: Observations and Pilot Studies
On Board the *Explorer of the Seas*

Dr. Edward J. Kearns
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098
Phone: (305) 361-4057 fax: (305) 361-4622 email: ekearns@rsmas.miami.edu

Dr. Otis Brown
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098
Phone: (305) 361-4006 fax: (305) 361-4622 email: obrown@rsmas.miami.edu

Dr. Bruce Albrecht
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098
Phone: (305) 361-4043 fax: (305) 361-4622 email: balbrecht@rsmas.miami.edu

Dr. Peter Minnett
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098
Phone: (305) 361-4104 fax: (305) 361-4622 email: pminnett@rsmas.miami.edu

Dr. Hans Graber
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098
Phone: (305) 361-4935 fax: (305) 361-4622 email: hgraber@rsmas.miami.edu

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LONG-TERM GOALS

The maintenance of the Southeast Florida / Northern Caribbean component of the Southeast Atlantic Coastal Observing System (SEA-COOS) which provides real-time and archived oceanographic and meteorological data to the science and management communities.

OBJECTIVES

The University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS) maintains oceanographic and meteorological laboratories aboard the Royal Caribbean Cruise Lines Ltd. (RCCL) *Explorer of the Seas* to acquire a continuous, high resolution, integrated oceanographic and atmospheric data set covering portions of the southeastern United States, Bahamas, and Eastern and Western Caribbean on a bi-weekly basis. A community-accessible relational database and data storage system will permit efficient Internet distribution of *Explorer* data and products to researchers and modelers. Parameters available include time series of ocean and atmospheric temperature, salinity, subsurface current profiles, fluorescence, dissolved oxygen and organic matter, wind velocity profiles, short and long wave radiation, aerosol particle concentration, precipitation, fractional cloudiness, and cloud-base heights. Widespread access to these observations will significantly improve our understanding of atmospheric, oceanic, and coupled behaviors in the southeastern U.S., Bahamas, northern Caribbean basin and in larger-scale systems. The *Explorer's* repetitive regional coverage and extensive ancillary data products also provide an ideal test platform for innovative instrumentation.

APPROACH

The *Explorer of the Seas* routinely cruises alternating tracks every other week in the Eastern and Western Caribbean Sea. The combined instrument suite on the *Explorer of the Seas* associated with the oceanographic and atmospheric laboratories requires constant maintenance, upgrading and management. Routine maintenance, calibration or replacement of sensors occurs on a daily basis. Two Senior Marine Technicians serve as the Science Systems Managers aboard the *Explorer* on an alternating bi-weekly schedule. These individuals maintain the extensive computer systems and network, which interface between the instrumentation and the data storage devices both on the *Explorer* and residing on land at UM/RSMAS. The Science Systems Managers are responsible for the continuous operation of all sensors and maintenance of a sensor cleaning/replacement log including the logging of occasional system outages when they occur.

Instruments installed on the *Explorer* sample the ocean and atmosphere continuously every week of the year. The derived and measured parameters include salinity, sea surface temperature, skin temperature, ocean current profiles, fluorescence, dissolved organic matter, dissolved oxygen, air temperature, wind velocity profile, atmospheric pressure, longwave and shortwave radiation, aerosol particle description, optical depths, rain rates, cloud-base height and cloud fraction. Low-resolution, five-to-thirty-minute samples and averages of rapidly sampled data are delivered in real-time through RCCL's INMARSAT-B satellite communications link to UM/RSMAS and a display of a subset of these data are available on a web site within a few minutes of the measurements being made. Approximately 4 gigabytes of higher-resolution are carried off the ship on DVD-ROM disks weekly upon the ship's return to Miami.

We will initiate a pilot study of wave and ocean surface monitoring using the *Explorer of the Seas* radar. The use of ship-radar based observations of waves and current fields is in its infancy on commercial vessels (Nieto Borge, *et al.*, (1999), Hessner, *et al.*, (1999)). During initial outfitting of the *Explorer*, a provision was made to split out raw radar return data, which could be used for future research purposes with regard to waves and currents. The bridge operations on the ship currently include a nautical radar system, which produces a signal that can be utilized by a Wave Monitoring System (Wa Mos II; see Reichert *et al.*, (1999)). Based on the split signal, the WaMoss II system autonomously estimates real-time sea state information such as surface current speed and direction, significant wave height, wave period and wave direction.

A searchable relational database that stores data from the *Explorer of the Seas* on-line and an interface that permits their easy and efficient distribution to researchers worldwide will be a significant part of a regional as well as global integrated ocean observing system. Data searches will be available by a wide variety of variables, including data type, time period, and geographical area, to permit researchers to select and work with a manageable subset of this enormous dataset.

WORK COMPLETED

Since only 30 days have passed since the start of this contract, there have not yet been many completed task in FY02. The entire Explorer data archive is now on-line in temporary storage. The WaMOS system has been ordered, and the database disk storage system speced. Coordination with SEA-COOS personnel has started, and travel plans have been made to coordinate with the SEA-COOS community in Oct 2002.

RESULTS

Again, only 30 days have passed since the start of this contract, and as there have not yet been many results to report in FY02. Routine radiosonde deployments from Explorer have been established, but the realtime data feed to the NWSTG has not yet been completed.

IMPACT/APPLICATIONS

The data set collected from the *Explorer of the Seas* covers multiple goals of SEA-COOS. The cruise track of the *Explorer* (Figure 1) traverses through southeastern Florida coast waters and across the critically important Gulf Stream. This route provides a weekly measurement of Gulf Stream transport and heat flux that can be used in climate studies, input for boundary conditions into large-scale ocean or climate models, and global heat budget analysis. The *Explorer* provides additional environmental data, ocean current data and atmospheric boundary layer data that can lead to significant contributions in a variety of areas:

- hurricane modeling and prediction in the North Atlantic
- moisture advection into the southern Great Plains areas through the low level atmospheric jets
- larval recruitment, as it pertains to the ability of U. S. fisheries managers to make educated decisions regarding regional fish stocks

- the evaluation of tourism impacts in ecologically sensitive Caribbean coastal zones where human impacts are focused within limited land and coastal marine assets
- the distribution and variability of marine and atmospheric pollutants within the Florida coastal waters, the Bahamas and the northern Caribbean basin
- the collection of validation/calibration measurements for satellite remote sensing studies
- the quantification of boundary layer processes.

These types of data are critical for monitoring the changing environment in the coastal regions of the southeast United States and the Caribbean.

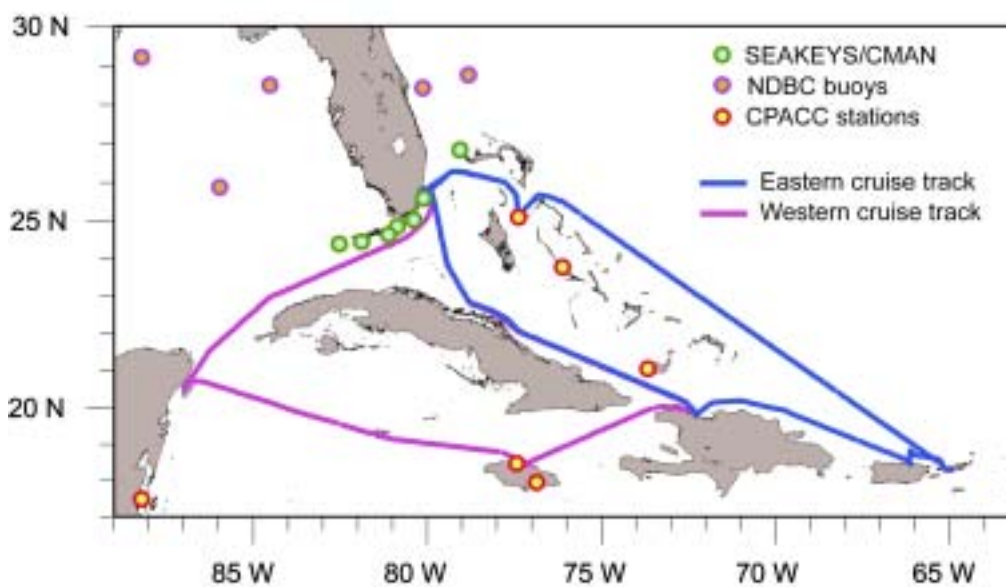


Figure 1. The Explorer cruise tracks: Eastern (blue) and Western (purple) routes plotted with some sample stations from SCOOP (SEAKEYS and NDBC buoys) and CPACC monitoring stations. The western and eastern routes share a common Miami, FL to Haiti leg

TRANSITIONS

The data set that has been collected from the *Explorer of the Seas* is freely accessible to any interested researchers. Numerous researchers, including RSMAS, NOAA/AOML, NOAA/NCEP, NOAA/NESDIS, Brookhaven National Lab, and ONR personnel, have requested and gained access to the data this year. Subsets of real time data (standard met, SST and salinity) are routinely sent on the hour to the NWSTG in WMO FM-13 and FM-62 format, respectively, which then transmits those data to the GTS, NCEP, and the VOS program at NDBC.

RELATED PROJECTS

The real-time and archival data that have been obtained and will continue to be obtained during cruises of the *Explorer of the Seas* will also enhance a number of present and ongoing global and regional programs. The SURA Southeastern Coastal Ocean Observing Program (SCOOP) is a regional program designed to be a publicly accessible network of meteorological and oceanographic sensors and linked computer models for the southeastern coastal zone. The *Explorer of the Seas* program extends this coastal observation network along the southeastern coastal waters into the Straits of Florida and provides upstream boundary measurements for the SCOOP program along the Bahamas island chain and across the entrance to the Gulf of Mexico. On a global scale there are programs such as the WMO Global Atmosphere Watch (GAW). The GAW system provides data on the chemical composition and related physical characteristics of the atmosphere. While there are presently 18 global GAW stations throughout the globe, the Bahamas and the Caribbean region --which lies at the key western end of the long pathway across the Atlantic taken by African dust particles -- is within a large coverage gap in the present GAW system. The *Explorer* instrument suite fills this gap, as it measures many of the same parameters as GAW stations around the world. Another complementary program is the 18 land-based climate monitoring (CPACC) stations presently established in the 12 Caribbean Community (CARICOM) nations; the *Explorer of the Seas* provides a complementary database to the standard meteorological data set and tide gauge time series collected at those sites.

REFERENCES

- Hessner, K., K. Reichert, and J. Dittmer, 1999: Coastal application of a wave monitoring system based on a nautical radar, In: *Proc. IGARSS Conf.*, 28 June - 2 July 1999, Hamburg, Germany, **Vol 1**, 500-502.
- Nieto Borge, J.C., K. Reichert, and J. Dittmer, 1999: Use of nautical radar as a wave monitoring instrument. *Coastal Engin.*, **37**, 331-342.
- Reichert, K., K. Hessner, J.C. Nieto Borge, and J. Dittmer, 1999: WaMoS II: A radar based wave and current monitoring system. In: *Proc. ISOPE Conf.*, 1999.

PUBLICATIONS

Research Combines with Public Outreach on Royal Caribbean Cruise Ship. Explorer of the Seas Research Group: (O. Brown, E. Prager, P. Minnett, B. Albrecht, H. Maring, P. Ortner, S. Cummings, D. Wilson, D. Palmer, E. Williams). Submitted to EOS.